BEST PRACTICES FOR HIGHWAY PROJECT COST ESTIMATING

by

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ABSTRACT

This thesis examines the estimating practices currently in use by state Departments of Transportation (DOTs). It presents a review of DOT estimating practices and discusses actions that help agencies produce estimates that are in line with the current challenges of large reconstruction projects in urban environments. The research involved all aspects of estimating from the conceptual estimate, to the final engineer's estimate (which are used for bid analysis). Additionally, issues such as project award and collusion detection are examined.

Data was collected from all fifty DOTs and analyzed based on the size of the DOT's construction program and estimating practice. Two major estimating systems are examined and compared: detailed estimating and historic bid price estimating. The two systems are compared and the final chapter discusses identified best practices.

Providing the personnel performing estimating duties with the right training and information as early in the estimating process as possible was determined to be the most influential factor in producing consistently accurate estimates.

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CHAPTER ONE

OVERVIEW AND STATEMENT OF PROBLEM

Large transportation projects are extremely expensive, with costs of individual projects reaching as high as $14 billion in recent years (Murphy, 2002). These mega projects require that a significant amount of money be obligated early in project development to ensure completion as planned. Estimating the cost of a given project is the responsibility of individual state departments of transportation (DOT). As a project is developed, so is its estimate (Figure 1). At the start of a project a conceptual estimate is generated based on limited information in order to work the project into the DOTs 5 year construction plan. Once the project is set in the five year plan, design can begin. Frequently the engineers performing these conceptual estimates use only historical bidding data to develop their estimates.

As a project progresses from concept to final design more of the unknown factors can be eliminated from the estimate and numbers that reflect the design can be produced (Figure 2). Estimates at final design, prior to bid, are often referred to as the state or engineer’s estimate, and are used to finalize project funding prior to bid solicitation and construction.

Project Stage	Concept Development	Design	Advertisement	Bid/ Award	Construction
Time	→	→	→	→	
Estimating Function	Conceptual Estimate	Design Estimates	Prebid Estimates	Bid Analysis Collusion Detection	Cost Analysis

Figure 1: Estimate Development in Relation to Project Development

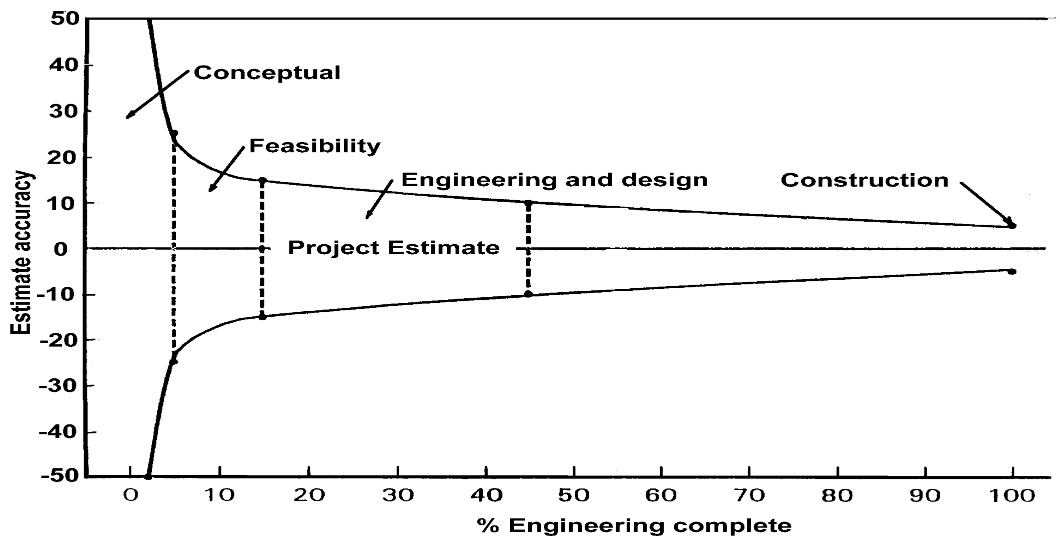

Figure 2: Estimate Accuracy vs. Project Development.

Problems arise when contractors submit bid prices that are significantly higher than the engineer's estimate prepared by the DOT. At this point either more money must be allocated or the project scope must be reduced in order to lower project costs to within budget limits. This frequently necessitates a significant amount of reengineering of the work which adds additional cost to the project while reducing its overall value.

This research examines the estimating practices currently in use by state DOTs. It presents a review of DOT estimating practices, throughout project development, with an emphasis on the final engineer's estimate. It discusses actions that help agencies produce pre-bid estimates that are in-line with the current challenges of large reconstruction projects in urban environments. DOTs have little experience estimating mega projects, the information presented here can help to improve the accuracy of estimates for such large one of a kind projects. Implementing good estimating practices make it possible to improve planning and budgeting accuracy, resulting in the delivery of quality projects within shorter time frames.

CHAPTER TWO

LITERATURE REVIEW

There are two textbooks available that focus primarily on procedures for producing heavy construction estimates. These books present the student with a general understanding of where to begin with a set of plans in determining the amount of work to be done and how to apply appropriate cost factors to that work in order to produce an estimate. Bartholomew (2000) and Parker (1984) focus on heavy construction projects and the unique challenges associated with these projects that would not be encountered in smaller scale operations of the same type.

A list of the steps for estimating a heavy construction project is included in each book along with some of the special conditions an estimator must consider while preparing an estimate for this type of project. These books are written as primers to teach students the mechanics of project estimating. They do not address the issue of estimating accuracy, they simply lay the foundation for preparing an estimate. These books provide the base knowledge of where to look for information and how to assemble it into a useful estimate.

Most information on Heavy Construction was published over ten years ago without consideration of the mega projects that DOTs are planning today. Although Bartholomew's book was published more recently it is based on information from sources, like Parker's book, that were originally published between ten and thirty years ago.

The problem of estimate accuracy affects all areas of construction and has been studied repeatedly. Investigations of this sort can be divided into two broad categories of study:

- Policies and Procedures of Estimating Entities.
- Technology for Estimating.

The majority of the studies have focused on a single estimating entity, such as one highway department, and reported successes and failures. These studies have included not only highway and infrastructure projects, but also building and industrial construction.

POLICIES AND PROCEDURES OF ESTIMATING ENTITIES

The process of estimating a construction project begins with the identification of a need and development of a conceptual estimate, and progresses with the systematic design of the project from concept to construction documents and development of the final engineer's estimate. In order to maintain both the scope and budget of the project it is necessary to manage the design to insure that all decisions will produce the best value possible for the owner.

Young (1997) suggests implementing a "Design to Cost" strategy. This idea involves constantly managing the design to ensure that the construction documents reflect a design that can be constructed for the budgeted amount. Although this sounds like a simple concept, it often happens that a design team will have a set of job requirements and a target cost, but then spend their time and effort in meeting all of the design

requirements while ignoring the escalating costs of the proposed design. The easiest way to control changes to scope, and their tendency toward cost increases, is through open and honest communication between the designer and owner. This process ensures that the owner is aware of any cost increase, beyond the original budget, and the designer is producing a design that meets the owners prescribed needs.

Once design is complete the owner or designer must once again go through the project carefully to produce the pre-bid or engineer's estimate based upon the final plans and specifications. This estimate can be produced by a quick check of the cost drivers that were tracked throughout the design. However, if the project scope has changed and the resulting costs were not previously identified, the estimate produced at this point can result in a tremendous shock when the project cost is finally revealed. If the latter event occurs, it is necessary for the owner to make more funding available or for the designer to go back and make design changes.

In order to increase the accuracy of estimates, De La Garza (1991) suggests that the personnel performing the estimate possess both a strong knowledge of costs as well as implicit design knowledge. The design knowledge helps to ensure all characteristics of a particular building system are included in the estimate. Without the appropriate design knowledge it is possible that an estimator may not understand that systems each have their own respective costs and a particular system can make a significant bottom line difference.

A common method for creating estimates is using standardized formats for delineating individual work items. For building work the most widely used of these

formats is the Construction Specifications Institute (CSI) Master Format. The sixteen categories (divisions) of the Master Format allow for easy organization of all aspects of the contract and estimate (Uman, 1990). By using a cost estimating methodology that follows this format the estimator can easily produce a detailed accounting to determine exactly what was and was not included in the estimate, as well as easily cross reference the contract specifications that determine what type and quality of materials are required for each element in the structure. An additional benefit of using this method is that contractors can use the same system to produce their estimate, and after bid opening the owner can directly compare contractor bids to the pre-bid estimate, providing an easy way to evaluate estimating practices and make changes as necessary.

The American Association of State Highway and Transportation Officials (AASHTO, 1998) has developed a similar format for use in highway construction. This guide has eight divisions that cover all aspects of highway construction, while eliminating or consolidating the other CSI categories that are seldom used for highway work. The AASHTO format is used throughout the United States as an outline for specification writing and payment monitoring by DOTs. State DOTs either use the standard numbers supplied by AASHTO or modify them to suit their individual needs.

The methods discussed thus far pertain mainly to owners and designers, the responsible parties up to the point where bids are solicited. Prior to bidding the project, contractors collect the bid documents, arrange site visits, and estimate the cost plus mark-up required to complete the project as designed. A contractor’s estimate is based on completing the work and making a profit. There are several pitfalls that the contractor

can experience during the estimating process that can lead to financial hardship later if the contractor successfully bids a job on an incomplete estimate (Paek, 1993). These include: 1) underestimating the time duration of construction, 2) a quantity takeoff mistake, and/or 3) selecting a construction method that is not allowed by specification. Even if the material quantities are correct, an underestimate of time (productivity) will lead to large labor cost overruns, as well as increased overhead to run the project for an extended period of time. To prevent this from happening the contractor's estimator must take into account regional differences in labor productivity and availability that may differ from normally anticipated production.

Several studies have looked at methods for producing bid estimates. Stern (1994) proposes a methodology based on current market information while downplaying the role of historical data. He suggests that market influences can alter prices and productivities enough to break an estimate that is based solely on historical figures that may not reflect current conditions. Shash and Al-Khaldi (1992) agree with this theory, but they also advocate including an evaluation of the economy as a whole, as a part of the estimate. This allows for adjustments to prices and predictions as to where overall costs are likely to be throughout the duration of the project.

Market conditions can greatly impact the bids submitted to an owner. Pearl (1994) found that when the market is in decline contractors will undercut their profit in order to become the low bidder and secure as much work as possible. As a result, owner estimates done prior to bid in a declining market will have a tendency to be higher than bid prices, while those done during periods of growth have a greater likelihood of being

low. In a growth market contractors generally have a larger backlog of work available and are, therefore, able to apply their usual mark-ups to their costs. Thus, owner estimators must increase their estimates during growth markets, which can widen the gap between an owner's estimate and the bid amount the next time the market turns down.

Other market conditions that can effect estimates and bids are: 1) the availability of labor, 2) location of the project, 3) equipment that requires specially certified sub-contractors to install, and 4) the overall condition of the economy, such as changes in interest rates that can change the amount of capitol required to fund a long term project (Shash, 1992).

TECHNOLOGY IN ESTIMATING

Since the advent of microcomputers and their proliferation into the business environment estimators have developed new and innovative techniques to produce estimates faster and better. Creating a computer program that can simplify the work of estimators requires a substantial commitment of personnel and resources. This commitment, or investment, can quickly return large dividends.

Hicks (1992) outlines the specifications that an estimating program should adhere to in order to produce viable estimates. These include: 1) clear definitions of all terms and actions, 2) an easy to use and understand interface, and 3) some method for tracking each and every part of the estimate, as well as option lists for each portion of the estimate, such as altering pavement type or thickness. Although there are many estimating

programs currently available from commercial sources, no single program has demonstrated that it is far superior to the others.

Regression Analysis

The Alabama Highway Department (AHD) developed and tested a conceptual estimating program based on regression analysis. To populate the program model, bid data from a variety of bridge widening projects were examined and individual line items were compared to determine average prices that would be used in future estimates. These figures were then tabulated and used to create the model. This model produced estimates consistently within $\pm$ 20% of the low bid amount, which was the requirement set forth by AHD in creating the program (Sanders, 1992). This model has limited applicability, as it only addressed estimating bridge widening projects. However, the methods used to create the model can be applied to other types of work to create similar models.

Neural Networks

Artificial neural networks have the capacity to perform a large number of calculations and also make decisions with minimal user input. The estimating neural network is initially developed by loading historical data, or in the case of highway estimating, line items, into the network and allowing the network to learn cost relationships. Al-Tabtabai and Tantash (1999) developed such a network for preliminary highway construction estimation. Their network was able to produce estimates accurate to within $\pm$ 9% of estimates created by a panel of industry experts. Use of such a program to perform detailed estimation would require much larger data sets and longer training periods than

were used in their study. However, once completed the network would be able to produce estimates far more quickly than humans.

Monte Carlo Simulation

In order to address the variability involved with cost estimates Touran (1993) developed a probabilistic cost estimating system. By using Monte Carlo Simulation applied to RSMeans data for low rise buildings, he was able to develop an accurate model for predicting the cost of line items that generally exhibit the greatest amount of variability. His model generated correlated random numbers from the data, and then applied those numbers to user-defined quantities in order to develop an estimate.

All of these methods use the power of computers to produce estimates faster, cheaper, and better than previously thought possible. Technology will definitely play a large role in the future of highway estimating, but a significant investment will be required to realize the full potential of computerized estimating systems.

CONCLUSION

While all of these studies examined estimating as a whole, and many have made recommendations for improving the practice, none has made a comprehensive comparison of methods currently in use. Other articles have made recommendations for improving performance on individual tasks that are a part of the estimating process, but the proposers have not tested their hypotheses, and therefore they do not have any empirical data for comparison to other methods for completing the same tasks. While the experience base for construction cost estimating, both in industry and in government, is quite large there is comparatively little published on the subject as compared to other

areas of engineering and construction practice. The competitive nature of the low-bid construction market discourages the free and open exchange of ideas on estimating, as each and every contractor closely guards any information that gives it an advantage when bidding. As a result, researchers have little support from industry for research that will help other contractors, even if the research also benefits the company that provides funding. This study produces a comprehensive listing of state DOT highway estimating practices. The information should help all state DOTs produce better project estimates.

CHAPTER THREE

METHODOLOGY

In order to determine the current state of estimating practice within state DOTs all fifty DOTs were contacted and interviewed. Points of contact were generated using an AASHTO committee member list and by researching state DOT web sites. Once appropriate contacts were identified they were electronically forwarded an advance copy of the survey and an interview was scheduled.

The original survey generated by the research team was tested with the Arizona DOT (ADOT). After discussions with ADOT that initial survey was refined and distributed to the other 49 states (Appendix A). Most states were interviewed over the phone, however some states were visited and interviews conducted with multiple personnel. Conducting the interviews either over the phone or in person, enabled the team to expand on comments and ask further questions for clarification. The interviews were used to collect data in four areas:

1) Document the state of practice:
    - Estimating practices of state DOTs
    - Details of good estimating practices
    - Impact of project type on estimating practice
    - Issues that cause estimate variance
2) Ascertain methods for the resolution of discrepancies between DOT estimates and bid prices
3) Identify problems that remain largely unresolved across the country

4) Determine practices that produce estimates with a ± 5% variability between the DOT estimate and contractor bid.

DATA ANALYSIS

While data was requested from all fifty states on projects valued at over $10 million, it was determined that to make the data more useful to the reader, project ranges would have to be established, and some differentiation between DOTs would be required. After discussions with ADOT, project value ranges were set to give a better idea of how DOTs are doing business while at the same time capturing useful data from all of the state DOTs. The number of projects used to determine program size was decided after the data was received from the DOTs. The data was sorted based on total projects reported and the breaks were based on gaps between the numbers, and a desire to maintain a sufficient number of DOTs in each category so as to allow conclusions to be drawn.

CONCLUSION

Implementing this methodology produced the required information from a large number of sources. It is anticipated that most DOTs have areas that could benefit from implementing new estimating practices, however without quantifiable data to show that these practices will improve estimating accuracy no DOT will adopt new or different practices. This research produces the information that state DOTs need to help them improve their estimating practices.

CHAPTER FOUR

HOW STATE DOTS ESTIMATE

Throughout a project's development estimates are completed to ensure that sufficient funds have been allocated to complete the proposed work. This study is primarily concerned with pre-bid estimates; however, conceptual estimating procedures were also examined to determine the extent of estimating procedure standardization within DOTs. The chronological development of a project estimate begins with the conceptual estimate and evolves through project development until the final pre-bid estimate is produced.

CONCEPTUAL ESTIMATES

Conceptual estimates are prepared by either project developers, designers, or estimators depending on the policies of the individual DOT. To create a conceptual estimate, 31 DOTs use estimating cost data that are based solely upon historic lane-mile cost averages for similar projects or for bridges/structures, they use historical square-foot or square-meter cost data. Eighteen other states go into greater detail and determine quantities based on the conceptual design and follow the same procedures that are used for pre-bid estimates, which could be either historic average unit price estimating or, as is the case in three states, prepare detailed estimates based on preliminary design information. One state reported allowing engineers to use whatever method they thought best to generate conceptual estimates.

In order to accommodate minor scope changes and account for engineering costs early in the project, most DOTs add a contingency amount to the conceptual estimate. This is usually a percentage of the total project cost. The reported range for

contingency was 5 - 45% depending on the type of project and amount of uncertainty prior to design. Overlay projects would generally be at the low end of the contingency scale, while tunneling would be towards the top due to the great variation in soil type that can be encountered when working beneath the surface of the earth. Table 1 shows the number of DOTs that reported using set percentages for all projects, as well as how many use a graduated scale (Table 2) based on estimated project cost, and how many require estimators to perform a cursory analysis of the risk and unknowns for the project and apply an appropriate percentage to address these uncertainties.

Table 1: Engineering and Contingency Costs Applied to Conceptual Estimates

Conceptual Contingency	DOTs Practicing
Set Percentage	20
Graduated Scale	15
Engineering Judgment	15

Table 2: One DOT’s Graduated Contingency Scale

Project Value	Conceptual Contingency
$0 - $1,000,000	11.0%
$1,000,000 - $5,000,000	9.5%
$5,000,000 - $25,000,000	7.0%
$25,000,000 +	6.0%

Life cycle cost is an important consideration in project development and if considered at all, is generally considered at the conceptual design phase. DOTs reported that life cycle cost analysis was done in the conceptual stage to determine the materials to be used in the project, as well as to perform initial value engineering studies. Twenty-

seven DOTs consider only pavement type during life cycle cost analysis and make a decision based upon their previous experience with facilities in the same general area and construction funds availability. Nine other DOTs reported they were unaware of any life cycle cost analysis being made during project development.

CRITICAL ISSUES REVIEW MEETINGS

These meetings are intended to focus extra attention on specific projects that are larger or more complex than usual. Personnel from all major areas of the DOT, such as planning, design, construction, traffic, and maintenance, are invited so as to gain the benefit of having multiple perspectives examine the proposed project. These meetings are normally held before the project is passed from planning to design. By bringing all of these perspectives together early the designers are able to reduce conflicts and value engineer the project upfront, instead of completing a substantial portion of the design before asking anyone to review the design plan. This process can save time and money as well as provide the public with a more useful facility. Eight DOTs that have these meetings require them for projects valued over $25, $30, or $60 million. One of those DOTs also uses this type of meeting for all Design-Build projects. Two DOTs hold these meetings for projects with extensive urban traffic control requirements, and one DOT uses these meetings to address special environmental, social, or right of way issues that exist.

DESIGN PHASE COST CONTROL

During the design phase of a project it can be useful to track the programmed (or budgeted) cost of the project against the anticipated construction cost of the final

design. This enables DOTs to better manage their construction programs by giving supervisors and directors an accurate overview of the costs associated with projects under design. As design progresses it may become clear that insufficient funds have been allocated based upon an unknown site condition, a change in project scope, or changes in the construction market. When this is discovered it must be reported to managers and either a cost increase approved or design changes made to bring the cost inline with the budget.

Approval authority for small cost/scope changes in nine DOTs is delegated to the district engineer responsible for the project. Large cost/scope changes however, must be approved by the DOT's director, or the budget committee in these states. These reviews encourage designers to find ways to stay within the project budget, and when that is not possible ensures that the changes are necessary and make sense within the DOT's overall construction program.

PRE-BID ESTIMATES

From the survey results it is clear that two methods of estimating dominate state DOT practice. The first method is the preparation of detailed estimates based on specific crews, equipment, production rates, and material costs. This is similar to the way a construction contractor would estimate a project. The other method is based on the use of historic bid averages. Most states that perform detailed estimates do so only for major items of work, which account for 65 - 80% of a project's cost. The remainder of the work items are estimated using historic bid averages. States using historic bid price

estimating systems reported applying these cost factors to all work items in a project to develop the estimate.

Detailed Estimating

Detailed estimating requires a great deal of knowledge about construction methods, supply systems, labor markets, and method productivity specific to the area where the work is being performed. It also requires more time to prepare a detailed estimate than that which is needed for estimating methods that simply apply bid averages to work items. This is because the estimator must conceptualize the construction process in order to prepare an accurate estimate. Nineteen states perform detailed estimates for major work items, using historic databases to track costs based on crews, equipment, and production, as well as to provide work item costs for minor items in the estimate. Most state DOTs that do this kind of estimating have dedicated estimating sections whose personnel have the necessary construction experience.

DOTs that do perform detailed estimates typically use computer software that supports estimate development, but the software is not critical to the estimating process itself. The software may be used to track cost trends or simply allow the estimator to report the estimate to other sections of the DOT more efficiently. The basic information that is necessary to perform a detailed estimate such as crew sizes, equipment types, production rates, and labor and material costs can be derived from a variety of resources. It is important that the estimator be familiar with available resources, how to find the

resources, and most importantly has a competent knowledge of construction processes. All of these elements are necessary in order to develop an accurate cost estimate.

Historic Bid Price Estimating

Creating cost estimates from historic bid prices is a relatively straightforward and quick process. Estimators need only be able to perform quantity takeoffs from a set of plans and match these quantities to the appropriate historical unit-bid prices or average historic unit-bid prices. In order to generate unit price data the department must systematically compile bid data from past project lettings broken down by line item. Average prices can also be calculated for the estimator's use. DOTs reported several different methods for sorting the data collected from bid documents.

The first decision is how many bids from each project should be included in the data. There is significant variance as to how DOTs approach this issue.

- Low bid only - 20 DOTs
- Low and second bid - 1 DOT
- Three lowest bids - 15 DOTs
- All bids (but may exclude single bids that are very high or low) - 11 DOTs
- All bids except high and low - 2 DOTs
- Bid analysis to determine a reasonable bid amount for each line item - 1 DOT

Table 3 summarizes the estimating performance for each of the above practices and includes data from both historic bid price estimating DOTs and detailed estimating states that track costs for minor work items. DOTs that use all bids except high and low, or the

one using a reasonable price reported the best performance. However, there was insufficient data to compare these two systems on a larger scale to other systems. Similarly, as only one state uses the low and second low bids this could not be compared either. Of the remaining practices, using the three low bids for each item was found to produce the best results, while using all bids produces the worst. This is most likely due to the fact that if a single bidder uses greatly unbalanced prices it can skew up or down the individual item averages in the database.

Table 3: Number of Bids Used for Historic Bid Price Estimating

Number of bids used	Number of DOTs	Reported Projects	Number reported more than 5% over Estimate	%
Low only	20	755	169	22.4
Low and Second	1	24	13	54.2
Three Lowest	15	497	88	17.7
All	11	260	74	28.5
All Except High and Low	2	64	3	4.7
Reasonable Price	1	24	1	4.2

After it is decided which bid prices will be used to create the average price, a timetable must be established that specifies the frequency of data updates. Databases can be refreshed and updated after each letting, or on an annual or on some other recurring basis.

In addition to these two factors, how many bids to use and how often to make system updates, the department must decide for what period of time data will be retained in the database and how far back price data should be considered to determine average prices

used in estimates. Typical look back periods are 1 year, 18 months, or two years for use in averages. Nine DOTs retain data for as long as records exist. Estimators can examine and use this data for items that are not frequently encountered or items that have seasonal price swings that one years data may not provide an accurate range for estimating.

Computer Use

Computer software gives DOTs the ability to manage large data sets that cover all project types. The most widely used DOT estimating software is “TRNS*PORT,” developed by AASHTO and InfoTech. This package is used in some capacity by 25 DOTs, with two other DOTs in the process of implementing the software. Another commercially available system that is used by several DOTs is “Bid Tabs” by OMAN systems. It is used either as a stand alone or in conjunction with “TRNS*PORT” by seven DOTs. Two other DOTs are in the process of testing this software. One DOT uses HCSS Heavy Bid which is a program used by many contractors and was originally developed to facilitate detailed estimating by a large contracting organization. One DOT uses AutoCAD to perform quantity takeoff for project estimates, by combining plan views of the project area with elevation information to get a three dimensional view of the project.

Eighteen DOTs are using programs that were developed within the DOT. These are not commercially available and are used either as stand alone systems or in conjunction with other software. These programs generally have limited capabilities and were designed to run on mainframe computer systems. Legacy programs like these are difficult to update or modify.

Personnel

Estimating experience of DOT personnel charged with developing estimates ranged from less than one year to more than 40 years across the fifty DOTs. Several DOTs that reported having estimators with minimal experience stated that they had in recent years lost their most experienced personnel to retirement and they had not retained mid-level personnel to ensure that the overall experience level in estimating would remain high. Similarly, DOTs with high levels of experience among estimating personnel acknowledged that they may have difficulty replacing their highly experienced personnel with sufficiently skilled personnel when their current estimators retire. A few states have recognized the benefit of having personnel at all stages of professional development in their department and have recruited in such a way as to ensure continuity as members retire over the next ten to twenty years.

Estimators come from many different specialties within the DOT including engineering, construction, contracting, and occasionally from the operations and maintenance areas. In twenty-six DOTs, estimating personnel are consolidated in a dedicated estimating section where their primary responsibility is the production of estimates. In the other twenty-four DOTs personnel prepare estimates as an ancillary duty while their primary responsibilities are likely to be either design or contract preparation.

Design consultants are used by all DOTs to produce project documents. This situation is caused either by a lack of DOT manpower or a need for specialized design knowledge. When consultants are used to prepare project documents they are usually required to submit a project estimate to the DOT for use in contract preparation. In

sixteen states this estimate is then reviewed by the DOT project manager who makes required changes before the official estimate for bid evaluation purposes is created. In another twenty-six states, this estimate is not used except to cross check the DOT estimate after the DOT estimate has been prepared. The remaining eight states reported using consultant estimates without modification or substantial checking.

Training

To ensure all estimators have current estimating knowledge, a training program is vital. This can be either a formal set of classes for all estimators, mentoring among the estimators in the section, or support for estimators to attend off-site conferences, seminars, or classes pertinent to their work. Ten DOTs reported having formal estimator training programs in place or under development. Mentoring and on the job training (OJT) are used extensively by all DOTs. Additionally most DOTs reported that the personnel preparing estimates have had experience either in design or construction prior to becoming estimators, and it is assumed that their personnel will have gained the necessary estimating knowledge and understanding either in school or in previous jobs. This previous experience, either from school or on the job, imparts a better understanding of the construction process and helps the estimator develop accurate estimates.

Whichever system is used, it is necessary for the personnel preparing estimates to understand how and why the system works. This is done either by having an estimating manual, or through OJT and familiarization with office policy. Currently sixteen DOTs

have manuals, either a separate estimating manual or a section within a design or other manual, that cover estimate preparation. Two other DOTs are in the process of developing estimating manuals. The remaining 32 DOTs do not have formal written guidance for estimate preparation that can be referenced by the estimator. If the experience level of personnel preparing estimates is not sufficient it will take extra OJT to bring them up to the appropriate level of understanding. Without a manual of practice or formal training program it is difficult for any DOT to produce consistent, accurate estimates, unless they are able to attract and retain personnel who have been trained elsewhere.

Time Frames

The time from completion of the DOT estimate to contract advertisement ranges from two days to three months. The majority of DOTs have a six to eight week range to allow sufficient time for internal estimate review. The reported DOT practice for completion of the final estimate is tabulated in Table 4.

Table 4: Time from Completion of Estimate to Advertisement

Time Frame prior to Advertisement	DOTs Practicing		
	Detailed Estimating	Historic Bid Average	Total
Within one week	2	3	5
One week to one month	6	5	11
One to two months	9	15	24
Two to three months	1	4	5
Three to five months	0	3	3
More than six months	1	1	2
Total	19	31	50

Advertisement periods range from 10 days to three months depending on project complexity and whether the project is being undertaken for emergency work. Thirty DOTs have three to four week advertisement periods with provisions for longer periods at the discretion of the contracting section. Five states were found to have three or four week firm advertisement periods that are not exceeded for any project. This policy is based on the idea that if a contractor cannot prepare a bid in the required time, chances are they do not have sufficient capacity to complete the project.

ESTIMATE ITEMS

Overhead

Project overhead is estimated almost exclusively by assuming that historic bid prices include the necessary mark up for overhead and profit. In DOTs that perform detailed estimates, unit prices are adjusted to account for overhead. Ten DOTs reported estimating overhead and profit directly based on individual line items, enabling them to more accurately account for special project requirements that vary from job to job.

Contractor Mobilization

Twenty DOTs limit the mobilization pay item to a predetermined percentage of the contract amount. In these states the percentage varied from a low of 3% in two DOTs to a high of 12% in one DOT. In twenty-six other DOTs, mobilization cost is determined based on historic average percentages after analyzing the project location, type of work, and schedule limitations. Other methods used for estimating mobilization are a sliding percentage scale based upon project dollar value where a set percentage is used for

projects in different cost ranges, or a graduated amount that adjusts as project value increases up to a maximum amount (Table 5). Graduated or sliding percentage scales are used in four states.

Table 5: Sample Graduated Mobilization Pay Item

Project Value	Mobilization
$0 - $500,000	8.0%
$500,000 - $2,500,000	$40,000 + 3% of amount over $500,000
$2,500,000 +	$100,000 + 1% of amount over $2,500,000

Demolition Work

DOTs estimate demolition work either as an individual line item, or assume it will be included in other pay items depending upon the specific type of demolition work. Ten DOTs prefer to have a separate contract for major demolition work prior to the construction contract. The decision to perform demolition under a separate contract is usually made based upon schedule constraints for the alignment or right of way, and whether there is sufficient time to perform required demolition before construction begins in an area.

Traffic Control

Traffic control is a difficult item to estimate as it requires a great deal of effort to properly conceptualize how the project work will be sequenced. One method used by DOTs for estimating traffic control cost is to use a predetermined percentage of the project's total cost. A variation on this method is to analyze the type of work, location,

and schedule limitations first, and then to adjust the percentage based upon those considerations. Twenty DOTs utilize one of these two methods for estimating traffic control costs.

The other predominant method for estimating traffic control is to analyze the project documents in detail and calculate total signage, temporary striping, flaging personnel, police, barriers, and other necessary items, each of which is multiplied by the appropriate number of project days to complete the work. This method, which is used by thirty DOTs, may or may not include an additional pay item for maintenance of traffic to cover other minor incidental expenses associated with traffic control.

DOT Supplied Materials

Twenty-three DOTs supply materials for contractor use. The most common material items supplied are permanent signs, signalization, and light poles. These are usually supplied to reduce the contract time, as these can be extremely long lead-time items for a contractor to procure. Additionally, a DOT can often save money on these items by purchasing large quantities when individual projects may only require a few of each. Other items sometimes supplied by DOTs were aggregate from state owned quarries, excess fill retained from other projects, and reclaimed asphalt material (RAP) or rubblized pavement from other projects. These are generally supplied only if readily available and more economical than using contractor furnished material. DOT owned traffic barriers are made available by some DOTs. When these are provided the contractor is responsible to pick up and return the barriers to a central storage facility.

UNIQUE AND SPECIALTY ITEMS

Most DOTs estimate these items similarly by calling suppliers, contractors, or other DOTs that are familiar with the work and asking for installed cost information. They then estimate the expected cost by adjusting the information they receive based on project location and current market conditions.

In some states talking to contractors about a specific job is prohibited. This is done to keep from giving one contractor an unfair bidding advantage over the other contractors by giving them more time to research their costs and find alternatives before bidding. Such rules limit the DOT's ability to gather information directly from contractors. This may force the estimator to create a detailed estimate for that single item or rely on information from another agency that may not have the same contract requirements and may have a lower cost than that DOT will realize at bid time.

OTHER ESTIMATING CONSIDERATIONS

There are several other project considerations that must be taken into account to prepare an accurate cost estimate for any project. These factors are part of the overall project but are not always captured by a single item of work, or may be in addition to standard specifications normally used by DOTs. All of these items can have significant costs associated directly with them or may significantly alter the costs of other items in the project.

Incentives

Incentives are used by many DOTs as a means to encourage contractors to perform above the minimum contract requirements. Currently the most common type of incentive is for early project or phase completion. An incentive notice is included in the advertisement and may compel contractors to bid lower if they feel they can complete the project in less than the allotted time. Early completion incentive clauses are often accompanied by disincentives for failure to complete the project on time. A disincentive is more punitive than the liquidated damages that would normally be assessed by the owner for late completion. Disincentives are structured in such a way that the contractor would be far worse off to complete the project late than to pay additional overtime or a premium for material in order to complete the project on time.

Incentives for pavement smoothness are also being used by some DOTs as a way to link quality directly to profit. This incentive is based on the construction specifications with any surface that exceeds the specified smoothness resulting in an incentive payment to the contractor. This can also be coupled with a disincentive to help motivate the contractor to meet specifications.

Funding of Incentives

The funds that are needed to make incentive payments must come from somewhere in the DOT budget before they can be paid to a contractor. The following practices were reported by DOTs using incentives:

- Incentive funds programmed in the construction estimate - 26 DOTs

This practice ensures adequate money is available to pay any incentive that is earned. This is based on the assumption that the contractor intends to earn the incentive. If the contractor fails to earn the incentive, or is subjected to a disincentive, the money that was set aside can then be used to fund other projects.

- Incentive funds come from other projects that were below budget - 9 DOTs

  These DOTs plan on having funds available from projects that under run their allocated budgets. This can cause problems within the DOT when a contractor earns an incentive but no other projects under ran sufficiently to provide the extra money. In order to compensate for any resulting funding shortfalls, future projects will have to be reduced in scope, delayed, or cancelled to provide the necessary incentive monies.

- Incentives paid out of project contingency fund- 10 DOTs

  These DOTs feel that budgeted contingency funds are sufficient to make incentive payments and do not budget any other funds solely for that purpose. In order for incentive payment to be made in these states a change order must be processed and approved for the incentive amount that was set forth in the original contract.

- No incentive program - 5 DOTs

Contingency

Contingency budgeting is done in order to provide funds for minor change orders, without forcing the DOT to request additional funds or reallocate funds from other projects. A contingency amount can be planned for and budgeted at project award. The reported range for contingency set asides was 3 - 19%. These additional funds are reserved within the DOT budget in a contingency fund to pay for minor project changes that arise during construction. These changes can result in additional cost to the DOT in payment for contractor work or to others (e.g. requirement to purchase additional right of way). This amount is not part of the estimate, and is generally not publicized outside of the DOT. Twenty-three DOTs use some contingency amount for project budgeting, while the remaining 27 states do not. The DOTs that do not use a contingency amount plan to make funds available from other projects if necessary to complete projects that overrun their budgets.

Schedule

Schedule can effect project cost and force modifications to estimates. This is generally driven by the owner requiring the project to be delivered very quickly, limiting contractor work times due to environmental or social goals, or requiring work during unusual times such as at night or only on weekends. These requirements increase project cost by forcing a contractor to either pay overtime to regular employees, or pay a premium to pull labor into the project area, or away from other contractors already in the area. Thirty-three DOTs consider this factor and examine project schedules when preparing estimates to

ensure they adjust the estimate appropriately. DOTs that do not analyze the schedule when preparing the estimate, assume that sufficient time has been allotted for the project based on previous experience in the project area.

Project Conditions

Project conditions such as restricted work areas, geographically separated staging areas, long haul routes, and site drainage problems as well as any number of other problems that are realized during design can significantly increase project costs above standard unit prices. When these factors are considered in advance, appropriate adjustments can be made to the estimate to eliminate surprises at the project letting. Thirty-eight states attempt to adjust estimate prices when they believe that there will be unusual project conditions that will cause the contractor to incur additional costs.

Project Location

Another major consideration for estimating is project location within the state. Thirty-eight states reported wide variation of bid prices within their states and adjust their prices accordingly for the geographic location of the project.

Table 6 is a summary of factors DOTs consider when preparing their estimates.

PROJECT AWARD

After advertisement each DOT conducts a letting where all bids are received. After the letting, all bids are compiled and an award decision is made. A decision must be made as

Table 6: Estimating Considerations

Factor Considered	Number of DOTs that Consider
Incentive Funds	
- Programmed in the construction estimate	26
- Come from other projects that are below budget	9
- Paid out of project contingency fund	10
- No incentives program in place	5
Contingency Budgeting	
- DOTs with contingency budgets	23
- DOTs without contingency budgets	27
Schedule	
- Estimate adjusted based on schedule	33
- Estimate not adjusted based on schedule	17
Project Conditions	
- Estimate adjusted based on special conditions	38
- Estimate not adjusted based on special conditions	12
Project Location	
- Estimate adjusted based on location within state	38
- Estimate not adjusted based on location within state	12

to the maximum difference between the DOT estimate and the low bid that is acceptable in terms of an award decision. For bids that are below the DOT estimate, regardless of the percent difference, twenty-six states require no action for award. Twelve DOTs require justification in order to award the project if it is more than 10 - 30% below the DOT estimate depending on the individual state's laws. Bids that are above the DOT estimate by 5 - 25%, depending on the individual state's laws, must be reviewed and may be rejected or awarded based upon an estimate review and/or a discussion with the contractor to determine why the difference occurred. Eight DOTs require all projects be reviewed prior to award regardless of percent difference (Table 7).

Table 7: Action Required for Project Award

Percent difference between DOT estimate and Low Bid	DOTs taking other action if percentage exceeded
No lower limit reported	26
Up to -30	1
Up to -25	2
Up to -20	2
Up to -15	2
Up to -10	5
Up to -5	2
All Projects Reviewed	8
Percentages Unknown/Unreported	2
Up to +5	3
Up to +10	31
Up to +15	2
Up to +20	2
Up to +25	2

The decision to award in some DOTs is left to the discretion of the contracting office, while most states require approval from a director, senior manager, or award committee before any project can be awarded, with special attention being paid to projects that are outside of the acceptable range, either over or under the DOT estimate. Bids are rejected when a project is outside of the acceptable range and there is no justification that the estimator or project manager can find for the price difference. The project will then be re-advertised at a later date with or without changes. If the award committee knows of other factors that are separate from estimating that require the project be awarded, no matter what the cost, they can decide to award at the higher price,

or enter into negotiations with the low bidder to bring the project to an acceptable budget amount.

Collusion

Collusion detection is the ability of the DOT to identify and track trends in bidding that would be considered criminal. In seven states little is done to actively detect/deter collusion based upon the idea that the construction industry is sufficiently competitive, fragmented, and distrustful of one another that contractors would not be willing to share the information that would be required for bid rigging.

Eleven other DOTs make contractors sign a form that is submitted with the bid. The form is a certification that there is no collusion and it makes contractors aware of the consequences should collusion be found. The most common method for performing collusion detection, which is used by 34 DOTs, is to run a bid history for each project and for each contractor to see if there is a pattern among winning contractors in a particular area. In DOTs that use TRNS*PORT, the BAMS module has been developed to aid in this task. Other DOTs either do this manually or use their own software.

One other method for collusion detection that was reported is bid analysis by either the state Attorney General's office or the DOT Inspector General. With this method estimators are not involved in or have little knowledge of the exact procedures being used. This is done in seven states.

Release of Information

The release of state estimate information to the general public and contractors varies from state to state depending on the Freedom of Information Act (FOIA) provisions under state law. Twenty DOTs were found to release, during project planning, only an anticipated project cost range.

Ranging information gives contractors an idea of project size and lets them know which jobs are within their bonding capacity. This is the only DOT information released in these states. After an award has been made, the low-bidder or all bidder information, along with the total project amount, can be found in the bid tabs that twenty-two DOTs post on their web pages (Appendix B). Ten DOTs go one step further and after all bids have been read release the total amount of the DOT estimate at the letting. This lets the contractors know right away whether the job will be awarded immediately or if there will be justification required prior to award.

Nineteen DOTs also release a complete copy of the DOTe estimate including quantities and unit prices along with the contractor bid tabs either after the bid opening or following award. One DOT announces the DOT's total estimate amount at advertisement. Two DOTs were found to have such extensive state FOIA requirements that all project documents, including the full DOT estimate, must be made available to anyone requesting it at any stage of project development. To help accommodate this one of these DOTs announces the DOT estimate in the advertisement and contractors may request copies of the entire estimate to consult during their own estimate preparation.

PROJECT DATA

In order to compare the estimating performance of individual DOTs, data was gathered on all projects bid having a value greater than $10 million over the last five years. Project data was aggregated into four ranges: between $10 and $25, $25 and $100, $100 and $200, and in excess of $200 million. Additionally, the number of these projects that exceeded the DOT estimate by 5% or more, at the time of the bid letting, was recorded to help determine the efficacy of DOT estimating procedures. DOTs were separated into three groups for analysis based on the number of projects they reported in response to the survey. DOTs that reported fewer than 20 projects greater then $10 million were classified as having small programs. Those that reported between 21 and 75 projects greater then $10 million were classified as having medium sized programs and those that reported more than 75 projects greater then $10 million were classified as having large programs (Table 8, Figure 3). Four DOTs were unable to provide historical project letting data.

Table 8: Project Estimate - Bid Comparison Data, All DOTs

DOT 5 Year Construction Program Size	Number of DOTs	Total Reported Projects	Number of DOTs with complete Data	Complete Data Reported Projects	Number	%
					more than 5% over Estimate	
Small (< 20 projects)	14	109	13	107	29	27.1
Medium (21-75 projects)	20	893	16	686	138	20.1
Large (76+ projects)	12	1362	9	1021	193	18.9
States not providing data	4	0	0	0	0	0
Overall	50	2364	36	1814	360	19.8

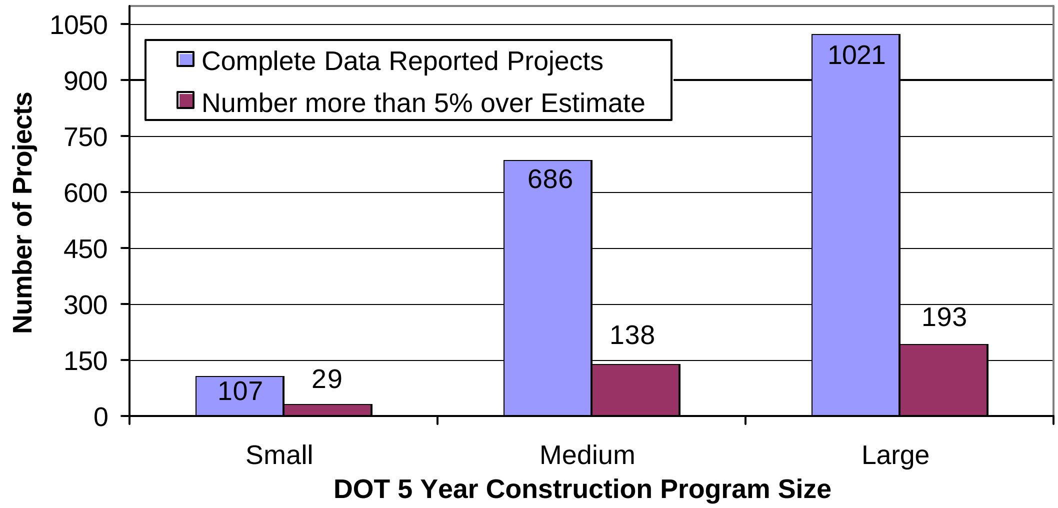

Figure 3: Project Estimate - Bid Comparison Data, All DOTs

The two types of estimating systems performed about the same for projects valued over $10,000,000, with detailed estimating DOTs reporting 19.6% (Table 9, Figure 4) being bid more than 5% over the DOT estimate and historic bid price estimating DOTs reported 20.1% more than 5% over the DOT estimate (Table 10, Figure 5).

Table 9: DOTs Using Detailed Estimating - Bid Comparison

DOT 5 Year Construction Program Size	Number of DOTs with complete Data	Reported Projects	Number more than 5% over Estimate	% more than 5% over Estimate
Small (< 20 projects)	3	31	7	22.6
Medium (21-75 projects)	3	193	34	17.6
Large (76+ projects)	7	648	130	20.1
Overall	13	872	171	19.6

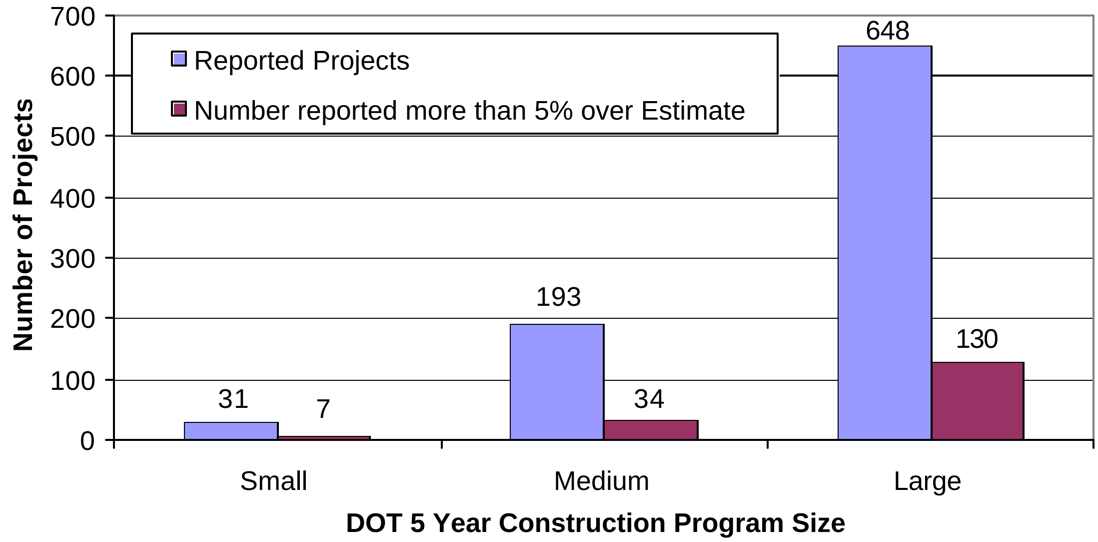

Figure 4: DOTs Using Detailed Estimating - Bid Comparison

Table 10: DOTs Using Historic Bid Price Estimating - Bid Comparison

DOT 5 Year Construction Program Size	Number of DOTs with complete Data	Reported Projects	Number more than 5% over Estimate	% more than 5% over Estimate
Small (< 20 projects)	10	76	22	28.9
Medium (21-75 projects)	13	493	104	21.1
Large (76+ projects)	3	373	63	16.9
Overall	26	942	189	20.1

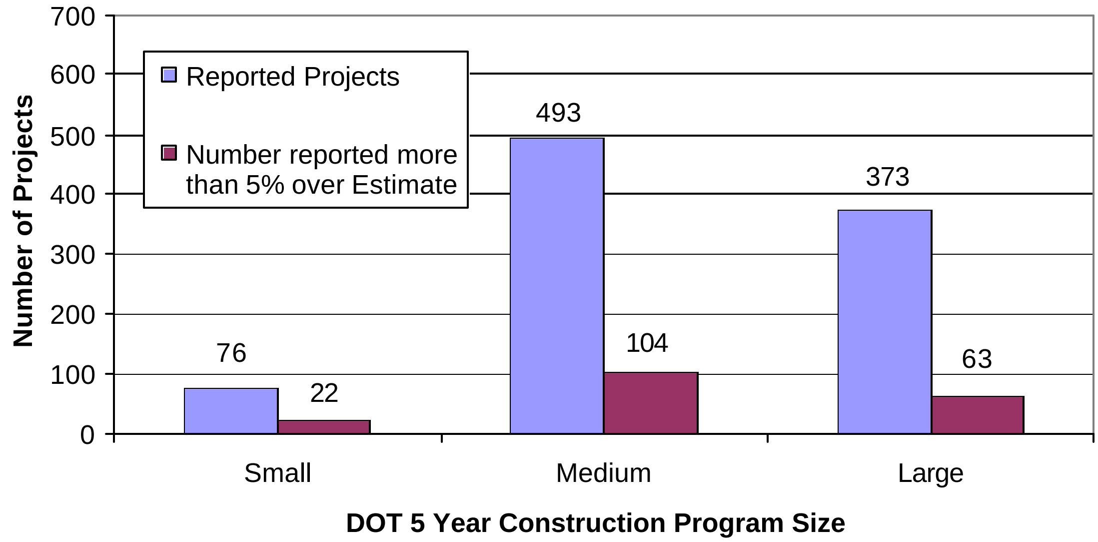

Figure 5: DOTs Using Historic Bid Price Estimating - Bid Comparison

Estimate Comparison - $10 - $25 million projects

The data was broken down further, within each estimating type, to determine which size program had the best performance in each project cost range. Table 11 and Figure 6 summarize the project estimating performance for projects valued between $10,000,000 and $25,000,000. Overall, DOT's with large 5 year construction programs, using either detailed or historic bid price estimating, and DOTs with medium sized construction programs using detailed estimating were the top performers in this project value range, all within 2% of one another. These DOTs have a great deal of experience estimating projects, and whether they prepare detailed or historic bid price estimates, are able to accurately capture the costs of construction for this project cost range. The worst reported performance (28.9%) was among small programs preparing historic bid price estimates. It appears that these DOTs have little experience or data for effectively estimating projects in this cost range. One possible reason for the lack of accuracy is that

the historic bid prices they are using are for much smaller projects that do not require the same commitment of resources. As these DOTs complete more projects in this range their historic bid prices should come in line and their estimating accuracy improve.

Table 11: Bid Comparison, Projects Valued between $10,000,000 and $25,000,000

DOT 5 Year Construction Program Size	Estimating Method	Number of DOTs with complete Data	Reported Projects	Number more than 5% over Estimate	% more than 5% over Estimate
Small (< 20 projects)	Detailed	3	30	7	23.3
	Historic Bid Price	10	72	21	29.2
Medium (21-75 projects)	Detailed	3	149	25	16.8
	Historic Bid Price	12	327	66	20.2
Large (76+ projects)	Detailed	7	491	81	16.5
	Historic Bid Price	3	251	38	15.1

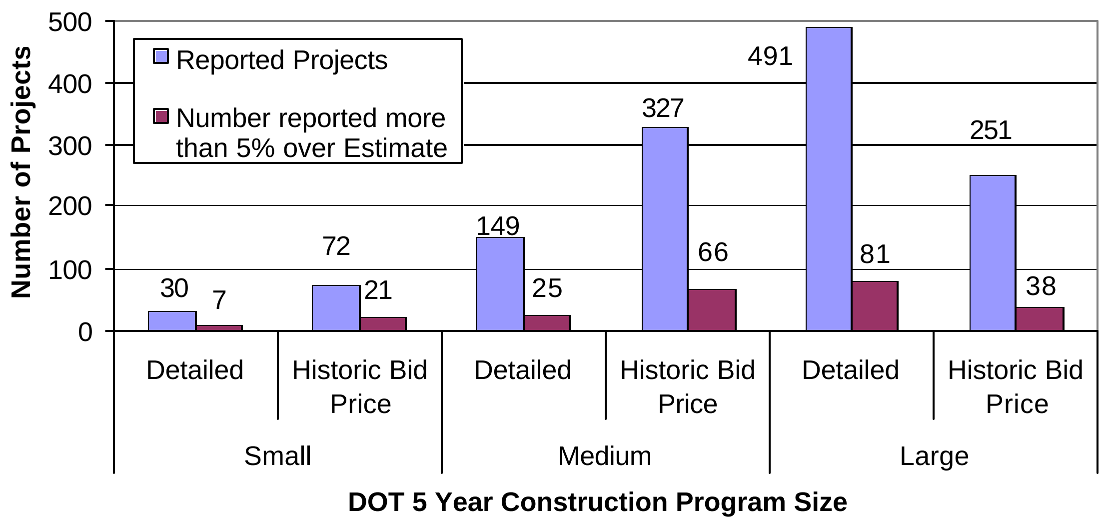

Figure 6: Bid Comparison, Projects Valued between $10,000,000 and $25,000,000

Estimate Comparison - $25 - $100 million projects

Projects valued between $25,000,000 and $100,000,000 (Table 12, Figure 7) are less common than those in the previous range. DOTs with small 5 year construction programs reported fewer than ten projects in this category. This number was insufficient for analysis. In this project range DOTs with medium sized construction programs performed similarly, no matter which estimating approach was used, detailed or historic bid price. Large historic bid price estimating DOTs in this category outperformed detailed estimating DOTs.

Table 12: Bid Comparison, Projects Valued between $25,000,000 and $100,000,000

DOT 5 Year Construction Program Size	Estimating Method	Number of DOTs with complete Data	Reported Projects	Number	%
				more than 5% over Estimate	
Small (< 20 projects)	Insufficient data for analysis (fewer than ten projects)				
Medium (21-75 projects)	Detailed	3	37	7	18.9
	Historic Bid Price	12	107	20	18.7
Large (76+ projects)	Detailed	7	149	43	28.9
	Historic Bid Price	3	116	24	20.7

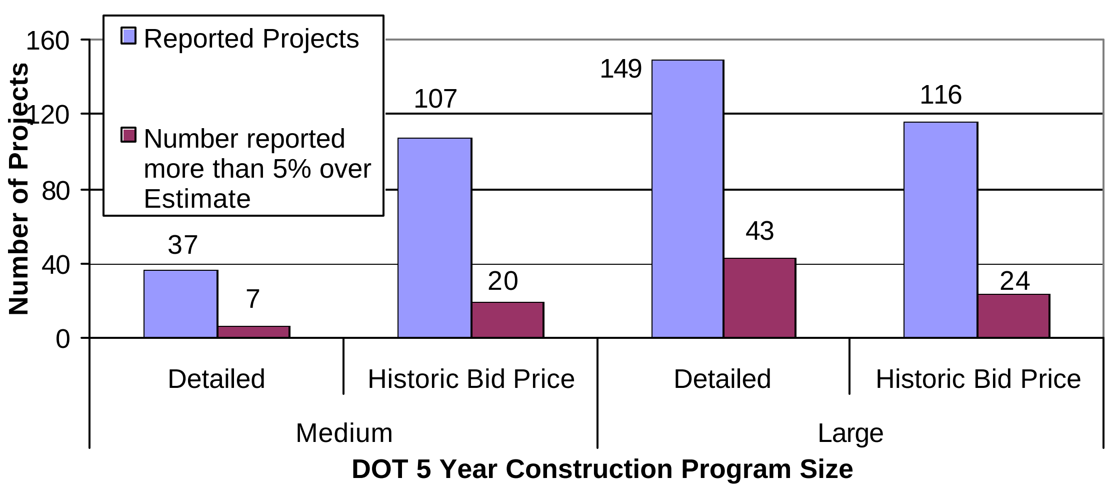

Figure 7: Bid Comparison, Projects Valued between $25,000,000 and $100,000,000

The two estimating systems are however much more closely aligned than the data would suggest as Florida, a historic bid price estimating state, had the best performance in this category with only 11.1% of their projects exceeding the DOT estimate by 5% or more. When Florida is excluded from the analysis, the large historic bid price estimating DOTs percentage for estimates over 5% above the DOT estimate rises to 26.8%.

One possible reason for the difference between the medium and large DOTs is that larger program DOTs may have more projects closer to the $100,000,000 mark, an area where they have less experience than with estimating projects closer to the low end of the range. Additionally, several states in this group reported great difficulty in estimating Design-Build projects accurately prior to bid. One DOT reported eleven projects in this project range, five of which were design build. Of the eleven, six were over the DOT estimate by 5% or more, and all five of the design-build projects were among the six that were over. The reason these DOTs cited for this estimating problem is estimators must create complete project estimates based upon 0 - 30% design documents. The contractors base their bids upon a complete study of all project issues as outlined in their own proposals, which includes much more detailed and possibly different design information. Depending on the project, the contractor may specify higher quality or different type materials than the state design standards, particularly if a project warranty is required. These changes can provide the state with a better facility and a usable facility in less time, both of which are goals of design-build projects. However, these attributes sometimes add significant costs. As a result, an estimate based on the early design

documents may only be as accurate as a conceptual estimate would be for another project.

Insufficient data was available for analysis on the two larger project categories by estimating type and DOT construction program size. For projects valued between $100,000,000 and $200,000,000 a total of 26 projects were reported with no more than eight in any single category. Of these 26 reported projects, 10 were reported as being more than 5% over the DOT estimate, or 38.5%. This extremely high percentage of projects is most likely a result of a lack of DOT experience in estimating projects this large (Table 13).

Table 13: Bid Comparison, Projects Valued between $100,000,000 and $200,000,000

Estimating Method	Number of DOTs with complete Data	Reported Projects	Number more than 5% over Estimate	% more than 5% over Estimate
Detailed	4	12	7	58.3
Historic Bid Price	8	14	3	21.4
Overall	12	26	10	38.5

Only eleven projects were reported in the $200,000,000+ project category and data was available for only eight of those. Of those eight, two or 25.0% were reported over the DOT estimate by 5% or more (Table 14). While this is better than the percentage for the next lower project range it is still a very high number when it is considered that these differences all involved at least $10,000,000. Projects of this size are not likely to be typical to any DOT anytime in the near future, however they are becoming more common across the country. DOTs should gather as much data as possible when preparing

estimates for a project of this size, including talking to DOTs that have executed projects of this magnitude, particularly those that received bids far above their estimates.

Table 14: Bid Comparison, Projects Valued over $200,000,000

Estimating Method	Number of DOTs with complete Data	Reported Projects	Number	%
			more than 5% over Estimate	
Detailed	3	3	1	33.3
Historic Bid Price	3	5	1	20.0
Overall	6	8	2	25.0

Anticipated Changes

Thirty-two DOTs currently have no near-term plans to make any changes to their estimating practices. Eight DOTs are considering implementing TRNS*PORT, either by converting to the system, or adding additional modules to their current system. Other DOTs are considering upgrading current in-house programs to perform better on today's computers, and the few DOTs that do not currently use computers for estimating are considering adoption of some computer system.

CHAPTER FIVE

BEST PRACTICES

There is significant difference between the estimating practices of individual DOTs without any consistency based on program size or regional location as might be expected. It appears that the estimating practices of any DOT are determined solely by the experience of the personnel in charge of estimating, either the head of the estimating section or chief of design. This exacerbates the situation where DOTs do not talk to their neighbors, who most likely deal with the same contractors, about pricing information. A great deal of knowledge could be gained if DOTs that generally use the same pool of contractors would discuss estimating practices. This would also make collaboration on and discussion of large project estimates easier between DOTs.

ESTIMATING GUIDANCE

DOTs would benefit greatly by producing a manual of standard estimating practices to be used by both DOT estimators and design consultants retained for estimating purposes. The availability of an easy to use guide, that prescribes the standard estimate format for the DOT, will greatly aid DOT estimators. With this guide estimators will be able to perform estimates in less time, as many of their questions can be addressed simply by reading the manual. The benefits would outweigh the cost of initial production and periodic updates to the manual. In order to reduce production costs and make changes less expensively the manual could be published and maintained electronically.

CONCEPTUAL ESTIMATES

A conceptual estimate should use the highest level of detail available for quantity takeoff and project scoping combined with recent bid information to set estimated prices. By incorporating a contingency amount into this estimate, based upon the type of work and uncertainty of the project conditions, the estimator can greatly improve the accuracy of the estimate. Although there is often very little information available at this stage of project development, the more detail an estimator is given the better the estimate.

DESIGN PHASE COST CONTROL

In order to ensure designers are aware of how design changes will effect project cost, it is advantageous to require submittal of a cost estimate along with each design submittal. When large differences between the conceptual estimate and the design estimate are reported (>10%), approval should be required from the supervisory level or higher before design proceeds in order to ensure sufficient funds will be available for construction. If the funds will not be available, changes must be required to reduce the overall project cost, this may cause a project scope reduction.

PRE BID ESTIMATES

A dedicated estimating section with personnel knowledgeable in the areas of design, construction, and estimating can best conceptualize and model all elements that are required for an accurate estimate. These personnel should be trained to use available estimating software. Preparing detailed estimates of major work items gives the DOT a strong footing for rejecting bids that are over their internal estimate, while performing

historic average cost estimates of minor items reduces the overall workload of estimators and requires fewer personnel to complete more estimates.

In DOTs that use historic bid price averages, the more information the estimators have about both the project and pricing of items, the more likely they are to produce an accurate estimate. In California cost sheets are generated for major work items detailed by item quantity ranges. Additionally, adjustment factors based on project conditions that may be encountered on any given project are provided. These factors are the result of extensive bid data analyses. Appendix C is a CalTrans Unit Price Factor sheet for Structural Concrete for Bridges. While this sheet cannot address all possible project conditions, nor can it tell the estimator exactly how much to add for any specific condition, it is a quick and concise tool for developing costs based on project conditions. In order for an estimator to determine how much to increase or decrease prices they must examine the work closely and not rely on a simple quantity takeoff from the plan sheets.

Consideration of all project conditions that effect price, such as location within the state, schedule constraints, and site issues is necessary to accurately estimate a project. The estimator must also know if any incentives are in the contract, and anticipate that the contractor will perform to the required standard, when creating the estimate.

AWARD

After receipt of the bids, the estimator or estimators that estimated a project should be involved in the bid analysis for that project prior to award. This will give them an opportunity to spot bidding trends early, and also ensure that someone that is

knowledgeable about the estimate is involved in the decision to award. Projects that exceed DOT estimate limits for automatic award generally receive this additional inspection, but to maximize the benefit of this process the same estimator that prepared the DOT estimate should be involved in both the bid analysis and award decision.

An additional responsibility of estimators is collusion detection. With proper training and adequate technological and legal support, estimators can include this step in normal bid analysis without appreciably increasing their workload. Estimators are the personnel in the DOT most familiar with pricing information from past projects and are most likely to notice when a group of contractors have suddenly changed their bidding habits. Additionally, by making estimators responsible for this portion of project development they will be forced to examine all projects to determine how contractors are bidding, aiding the estimator in determining the best unit price for any estimate item.

RELEASE OF ESTIMATE

The DOTs estimate should be available after award as a project total amount. This gives both the general public and contractors a chance to see the original projected project cost. However, the release of detailed unit prices may compromise future DOT estimates.

DESIGN BUILD PROJECTS

In order to accommodate the cost difference between contractor proposals and the DOTs pre-bid estimates for Design-Build projects the DOT can do several things. Since the pre-bid estimate is based on conceptual design information, treat the estimate like a

conceptual estimate and add a contingency amount to the estimate. This amount can be determined by having the estimator go through the Request for Proposals (RFP) and attempt to determine areas where the contractor may exceed the DOT standards in order to make their proposal more appealing to the award committee or to satisfy warranty requirements. These items can either be adjusted upward accordingly, or a range can be used in the estimate for these items, as well as in the pre-bid estimate for these projects. As more projects are executed under this system and the DOT accumulates data for the actual costs of such projects, separate price lists for use when estimating Design-Build projects can be developed.

Additionally, the DOT should assign estimators to the award team for these projects. These estimators would be responsible for examining the project cost proposal based on the information in the technical proposal. Since the technical proposal is likely to differ from DOT standard designs the estimator will have to ensure any costs they use in analyzing the cost proposal are valid based on the proposal requirements for time and quality.

PROJECTS VALUED OVER $100 MILLION

Projects valued over $100 million require special consideration of project conditions in order to produce an accurate estimate. The most experienced estimating personnel should be assigned to estimate these large projects. If personnel are not available the DOT should contact other DOTs that have completed projects of similar size and ask for assistance. If this is not possible, a construction consultant with the necessary experience

should be retained to help the DOT estimators. This will help the estimators account for all of the intricacies of the large project while at the same time giving them the necessary experience to prepare accurate estimates for mega projects in the future.

REFERENCES

1. AASHTO (1998). *Guide Specifications for Highway Construction.* Washington, DC.
2. Al-Tabtabai, H., Alex, A., and Tantash, M. (1999). "Preliminary Cost Estimation of Highway Construction Using Neural Networks," *Cost Engineering,* Association for the Advancement of Cost Engineering, Morgantown, WV. 41(3), 19-24.
3. Bartholomew, S. (2000). *Estimating and Bidding for Heavy Construction*. Prentice-Hall, Upper Saddle River, NJ.
4. Brown, J. (1997). "Construction Estimating and Bidding Strategy," *1997 AACE International Transactions*. Association for the Advancement of Cost Engineering International, Morgantown, WV.
5. De La Garza, J., and Oralkan, G. (1991). "Implicit Design Knowledge and its Impact on Cost Estimating," *Construction Congress Proceedings: Preparing for Construction in the 21st Century*. American Society of Civil Engineers, New York, NY.
6. Hegazy, T., and Moselhi, O. (1995). "Elements of Cost Estimation: A survey in Canada and the United States," *Cost Engineering,* Association for the Advancement of Cost Engineering International, Morgantown, WV. 37(5), 27-33.
7. Hicks, J. (1992). "Heavy Construction Estimates with and without Computers," *Journal of Construction Engineering and Management,* 118(3), 545-560. American Society of Civil Engineers, New York, NY.

8. Moreno, R., Spencer, C., and Schexnayder, C. (2000). "Survey of Methods and Practices of High Performing State Highway Agencies," Arizona Department of Transportation Report Number: FHWA-AZ00-489. ADOT, Phoenix, AZ.

9. Moselhi, O. (1997). "Risk Assessment and Contingency Estimating," *1997 AACE International Transactions*. Association for the Advancement of Cost Engineering International, Morgantown, WV.

10. Murphy, S. (2003). "Big Dig Review to Target Cost Overruns," *The Boston Globe,* 23 November 2002, A1.

11. Paek, J. (1993). "Common Mistakes in Construction Cost Estimation and Their Lessons," *Cost Engineering*, Morgantown, WV.35(6), 29-33.

12. Paek, J. (1994). "Contractor Risks in Conceptual Estimating," *Cost Engineering,* Association for the Advancement of Cost Engineering International, Morgantown, WV. 36(12), 19-22.

13. Parker, A., Barrie, D., Snyder, R. (1984). *Planning and Estimating Heavy Construction.* McGraw-Hill, New York, NY.

14. Pearl, R. (1994). "The Effect of Market Conditions on Tendering and Forecasting," *1994 AACE Transactions,* Association for the Advancement of Cost Engineering International, Morgantown, WV.

15. Sanders, S., and Maxwell, R. (1992). "Preliminary Estimating for Heavy Construction," *1992 AACE Transactions*, Association for the Advancement of Cost Engineering International, Morgantown, WV.

16. Sanders, S., and Maxwell, R., Glagola, C. (1992). “Preliminary Estimating Models for Infrastructure Projects,” *Cost Engineering*, Association for the Advancement of Cost Engineering International, Morgantown, WV. 34(8), 7-13.

17. Shash, A., and Al-Khaldi, Z. (1992). “The Production of Accurate Construction Cost Estimates in Saudi Arabia,” *Cost Engineering,* Association for the Advancement of Cost Engineering International, Morgantown, WV. 34(8), 15-24.

18. Stern, A. (1994). “The Best Estimating Methodology for Project Owners,” *1994 AACE Transactions*. Association for the Advancement of Cost Engineering International, Morgantown, WV.

19. Touran, A. (1993). “Probabilistic Cost Estimating with Subjective Correlations,” *Journal of Construction Engineering and Management,* American Society of Civil Engineers, Morgantown, WV. 119(1), 58-71.

20. Uman, D. (1990) “Is a Standard Needed for Estimating Building Design and Construction Cost?” *Cost Engineering*, Association for the Advancement of Cost Engineering International, Morgantown, WV. 32(8), 7-11.

21. Young, J. (1997). “Design Phase Cost Control,” *1997 AACE International Transactions*. Association for the Advancement of Cost Engineering International, Morgantown, WV.

APPENDIX A

SURVEY

NCHRP – Best Practices and Guidelines of Project Cost Estimating

Contact: J. B. Byrnes at Jonathon.Byrnes@asu.edu

The questions refer to estimates prepared immediately prior to bid letting unless otherwise stated.

1. Does your department have a dedicated estimating section or do personnel who also perform other duties prepare estimates? Are estimates prepared by design consultants?

2. What is the experience level of personnel performing estimates?

3. Is there a formal training program for new personnel in estimating?

4. Does the department, during the design phase of a project, impose a strict methodology to control the cost of construction? Yes ____ No ____.

   If yes would you describe? If there is a written protocol would you provide a copy?

5. Are there standard operating procedures for all DOT estimating departments? If so, how are they distributed and used?

6. Is the same system or set of procedures used for conceptual estimates and pre-bid estimates? If not, how do they differ?

7. During project design (as the project is developed) is it a requirement that changes resulting in cost variances from the original conceptual estimate be reported and approved?

   Yes ____ No ____ If yes at what level in the department is there approval authority?

8. Is there a formal review within the DOT of the estimate? Yes ____ No ____.

   a. Are personnel outside of the estimating section involved in the review? Yes ___ No___.

   b. Does the review include a discussion of schedule? Yes ____ No ____.

   c. Does the review include a discussion of project conditions (night work, required/ necessary weekend work, etc.)? Yes ____ No ____.

   d. Does the review include a discussion of site conditions affecting operations? Yes___ No___.

e. Does the review include a discussion of required sequencing of work/traffic control? Yes ____ No ____.

9. Does any project value trigger additional reviews, or a critical issues review meeting?

10. How many jobs in each of the following categories has your department executed in the last five years, and how many are planned in the next five years?
    a. $10,000,000 - $25M: Last five years:_________ Next five years _________
    b. $25M - $100M Last five years:_________ Next five years _________
    c. $100M - $200M Last five years:_________ Next five years _________
    d. $200M+ Last five years:_________ Next five years _________

11. How many of those jobs actually bid in each category were over the DOT estimate by 5% or more?

12. Does your state use a computer-based system for estimating, other than a supporting project tracking database? If so, what is the program; is it commercially available; and how is it used?

13. What units of measure or items of work are typically used in performing conceptual estimates? For example, is total sf of pavement used or is a more detailed estimate completed?

14. Are prices in this system updated based on bid data to develop historical average prices?

15. Is the system based on historical low bid cost data? If not, what is the basis for pricing?

16. Are neighboring state DOTs consulted when setting prices? About what issues?

17. Are contractors ever consulted about cost before a project estimate is prepared?

18. Are factors such as market conditions, anticipated time before execution, or geographic area of the state considered when preparing conceptual estimates?

19. Do you attempt to make a detailed estimate of project costs? (Detailed – means calculating production based on specific crews, equipment, and methods.)

20. Do you attempt of make a detailed estimate of major work items?

21. Do you attempt to make an estimate of project overhead costs (those project related costs that cannot be attributed to specific work items – required safety staffing, quality control staffing, temporary facilities, etc.)

22. How are mobilization and traffic control costs estimated?

23. Does your DOT ever provide materials for contractors such as aggregate, concrete, or asphalt? If so, when and why?

24. How are unique/specialty items priced? Those items for which historic costs are not available. Is there a review of the additional costs required to meet social goals?

MBE/WBE/DBE	Yes ____	No ____.
Project agreements.	Yes ____	No ____.
Noise control	Yes ____	No ____.
Limited work times.	Yes ____	No ____.
Other ___________	Yes ____	No ____.

25. Is the cost of demolition identified separately? Yes ____ No ____.

26. Are the costs of detours identified separately or included with traffic control?

27. Are state estimates ever released to the general public? If so, when and at what level of detail?

28. Are all projects awarded to a single general contractor or will specialty portions, such as bridges, be awarded separately? And at what economic level?

29. Are alternative project delivery methods allowed for use by state law? If so, how are these projects estimated differently than traditional design-bid-build projects? Additionally, what methods are you using and for what size and type of projects?

30. Does your DOT use A + B bidding? If yes, how are the two values used to determine a low bidder?

31. Is life cycle cost considered at any stage of project development.

32. How much time typically lapses between the department's estimate calculation and the bid opening?

33. What steps are taken when estimates are not close to bid prices? At what percent difference are these steps taken?

34. Is there a contingency amount incorporated into each project estimate? If so how is this amount determined?

35. For a conceptual estimate, what percentage (%) is used for engineering and contingency?

36. Are incentives used for early project completion, roadway smoothness or other items? If so, where does this money come from and is it set aside and planned for during estimating?

37. What is the time duration that contractors have for preparing their project estimates? Does this change based of the size ($) of the project?

38. How does your DOT prevent contractor bid collusion?

39. What system changes are you considering and why?

APPENDIX B

STATES WITH WEB BASED BID TABS

State	Bid Tab Web Sites
CA	www.dot.ca.gov/hq/esc/oe/awards/bidsum/
CO	www.dot.state.co.us/bidding
ID	www2.state.id.us/itd/design/contractors/contrinfo.htm
IL	www.dot.state.il.us/deserv/dearch.html
KS	www.ink.org/public/kdot/business/hwycont.html
MD	www.sha.state.md.us/doingbiz.htm
ME	www.state.me.us/mdot/project/design/bidtabarchive.htm
MN	www.dot.state.mn.us/bidlet
MO	www.modot.state.mo.us/bids/bidtabs.asp
MT	www.mdt.state.mt.us/cntrct/contract.htm
NC	www.doh.dot.state.nc.us/preconstruct/highway/dsn_srvc/contracts/bidaverages/
ND	www.state.nd.us/dot/pacer/bidopenrtpindex.html
NV	gis.nevadadot.com/contractor/business/contall.asp
OH	www.dot.state.oh.us/contract/estimating/files%20&%20info/files_and_information.htm
OR	www.odot.state.or.us/techserv/progsrv/costestm/
SC	www.dot.state.sc.us/doing/default.html
TN	www.tdot.state.tn.us/construction/
TX	www.dot.state.tx.us/business/business.htm
VA	virginiadot.org/business/const/resources-bidtabs.asp
WI	www.dot.state.wi.us/dbm/business.html
WV	www.wvdot.com/10_contractors/10a_lettings.htm
WY	dot.state.wy.us/web/business/contractor.html

APPENDIX C

UNIT PRICE FACTOR SAMPLE COST SHEET

STRUCTURAL CONCRETE, BRIDGE

UNIT PRICE FACTORS

BASE PRICE = $270/CUBIC YARD

CONCRETE IN PROJECT

20,000 CY±	7,000 CY±	2,500 CY ±	600 CY±	300 CY±
-15	0	+30	+80	+130

PROJECT LOCATION

Urban Area	Small Urban/City	Rural/Town	Distant Rural	Isolated
0	+25	+50	+75	+150

TRAFFIC

Over Traveled Way	Heavy Traffic/Congestion
+20	+10 to +80

WATER

Over Water

+10 to +150 (depending on permit restrictions)

FALSEWORK HEIGHT

20'±	40'±	60'±	80'±	100'±	120'±
0	+20	+45	+70	+100	+130

WIDENING/STAGED CONSTRUCTION

60'±	40'±	30'±	20'±	15'±	10'±	5'±
+10	+30	+75	+110	+150	+210	+300

OTHER FACTORS

Work Schedule (permit restrictions/ limited night hours/night work/expedited schedule)	Increase $20 to $400/CY
Restricted Access	Increase $20 to $150/CY
Arch Construction/Variable superstructure	Increase $20 to $60/CY
Rugged Terrain	Increase $20 to $150/CY
Slab Construction	*Reduce* $20 to $40/CY

APPENDIX D

SURVEY DATA

1. Does your department have a dedicated estimating section or do personnel who also perform other duties prepare estimates? Are estimates prepared by design consultants?

Number of DOTs	Response
19	Dedicated section prepares all final estimates.
1	Dedicated section prepares all final estimates as well as bid analyses.
1	Dedicated section prepares all final estimates as well as bid analyses. 8 districts, each does own estimating, decentralizing estimating to the district level
1	Dedicated section prepares all final estimates as well as construction schedules.
1	Dedicated section prepares all final estimates as well as contract prep and letting
1	Dedicated section prepares all final estimates as well as the letting documents and bid analysis.
1	Dedicated section prepares all final estimates as well as programming estimates
1	Dedicated section prepares all final estimates. Each district has an in-house estimator to assist HQ section with field investigations
11	No, designers prepare estimates, consultant estimates reviewed by PM
8	No, designers or consultants prepare final estimates
1	No, Contracts & Estimates prepares all final estimates as well as other contracting responsibilities
1	No, Contracts & Specs prepares all final estimates as well as other contracting responsibilities
1	No, designers prepare estimates, then supervisor reviews
1	No, designers prepare estimates. One reviewer reviews all estimates as requested, this is his only duty
1	No, eliminated and merged with QA this year, now perform plan review and spec check as well, get involved at problem statement

2. What is the experience level of personnel performing estimates?

Number of DOTs	Response
2	Unknown
15	Less than 10 years
19	10-20 years
10	20-30 years
4	30+ years

3. Is there a formal training program for new personnel in estimating?

Number of DOTs	Response
40	OJT only
1	NO, all DOT employees eligible to bid for estimating job with no training requirements prior to or once in job
1	Design engineer training program includes a class on estimating, and use of estimator software
1	Project estimating guide
1	Supervisor tailors training to prior experience of new personnel
1	2 manuals outline procedures and methods, one for conceptual, one for final
1	Cost estimating procedure not available outside department, provided to all engineers as guidance
1	Developed course and offered once but have not repeated in last two years
1	Developing plans review class
1	Estimating manual is under production but has not been approved yet, will outline policy and procedures for completing estimates
1	Individual one-on-one training

4. Does the department, during the design phase of a project, impose a strict methodology to control the cost of construction? Yes ____ No ____.

   If yes would you describe? If there is a written protocol would you provide a copy?

Number of DOTs	Response
35	NO
1	NO, but overall construction program budget may not be exceeded
12	YES, Estimate reviewed throughout design submission process by multiple divisions
2	YES, engineer responsible to deliver design within programmed amount

5. Are there standard operating procedures for all DOT estimating departments? If so, how are they distributed and used?

Number of DOTs	Response
20	YES, procedures are outlined in policy manual
4	YES, computer system users guide
26	NO

6. Is the same system or set of procedures used for conceptual estimates and pre-bid estimates? If not, how do they differ?

Number of DOTs	Response
11	YES
20	NO, Rough quantity takeoff done using lane miles or SF for structures
12	NO, Conceptual Estimates done in separate section
4	NO, use highest level of detail available
1	NO, Conceptual estimates have no standard procedures
1	NO, concept based on historic project data for similar size project, but not itemized
1	NO, concept focuses on big ticket items then add % to cover all other items

7. During project design (as the project is developed) is it a requirement that changes resulting in cost variances from the original conceptual estimate be reported and approved? Yes ____ No ____
   If yes at what level in the department is there approval authority?

Number of DOTs	Response
16	NO
24	YES, Headquarters management must approve changes
10	YES, District management responsible for own changes

8. Is there a formal review within the DOT of the estimate? Yes ____ No ____.

Number of DOTs	Response
21	NO
16	YES
7	YES, each estimate is reviewed by a PM or supervisor
5	YES, within estimating section
1	YES, chief execs of 6 divisions w/in DOT make up an estimating committee which reviews all estimates

a. Are personnel outside of the estimating section involved in the review?

b. Does the review include a discussion of schedule?

c. Does the review include a discussion of project conditions (night work, required/ necessary weekend work, etc.)?

d. Does the review include a discussion of site conditions affecting operations?

e. Does the review include a discussion of required sequencing of work/traffic control?

Number of DOTs					Response
a	b	c	d	e	
31	14	12	15	15	NO
19	36	38	35	35	YES

9. Does any project value trigger additional reviews, or a critical issues review meeting?

Number of DOTs	Response
37	NO
8	YES, Large complex projects over a preset $ amount
2	YES
2	Projects with extensive urban TC requirements
1	Special environmental, right of way, or social issues

10. How many jobs in each of the following categories has your department executed in the last five years, and how many are planned in the next five years?

a. $10,000,000 - $25M: Last five years:__________ Next five years __________

b. $25M - $100M Last five years:__________ Next five years __________

c. $100M - $200M Last five years:__________ Next five years __________

d. $200M+ Last five years:__________ Next five years __________

11. How many of those jobs actually bid in each category were over the DOT estimate by 5% or more?

DOT 5 Year Construction Program Size	Number of DOTs	Total Reported Projects	Number of DOTs with complete Data	Complete Data Reported Projects	Number	%
					more than 5% over Estimate	
Small (< 20 projects)	14	109	13	107	29	27.1
Medium (21-75 projects)	20	893	16	686	138	20.1
Large (76+ projects)	12	1362	9	1021	193	18.9
States not providing data	4	0	0	0	0	0
Overall	50	2364	36	1814	360	19.8

12. Does your state use a computer-based system for estimating, other than a supporting project tracking database? If so, what is the program; is it commercially available; and how is it used?

Number of DOTs	Response
18	TRNS*PORT
7	TRNS*PORT and in-house software
1	TRNS*PORT and OMAN Bid-Tabs Professional
2	OMAN Bid Tabs Professional
2	OMAN Bid Tabs Professional and in-house software
1	OMAN light Estimating, in-house for asphalt resurfacing
9	In-house
1	HCSS Heavy-Bid
1	AutoCAD quantity takeoff
8	NO

13. What units of measure or items of work are typically used in performing conceptual estimates? For example, is total sf of pavement used or is a more detailed estimate completed?

Number of DOTs	Response
31	Lane-mile/kM, SF/SM for bridges
18	Use as much detail is available
1	Engineers dicretion

14. Are prices in this system updated based on bid data to develop historical average prices?

Number of DOTs	Response
5	NO
45	YES

15. Is the system based on historical low bid cost data? If not, what is the basis for pricing?

Number of DOTs	Response
20	Low only
1	Low and Second
15	Three Lowest
11	All
2	All Except High and Low
1	Reasonable Price

16. Are neighboring state DOTs consulted when setting prices? About what issues?

Number of DOTs	Response
37	NO
13	YES

17. Are contractors ever consulted about cost before a project estimate is prepared?

Number of DOTs	Response
17	NO
33	YES

18. Are factors such as market conditions, anticipated time before execution, or geographic area of the state considered when preparing conceptual estimates?

Number of DOTs	Response
12	NO
38	YES

19. Do you attempt to make a detailed estimate of project costs? (Detailed – means calculating production based on specific crews, equipment, and methods.)

Number of DOTs	Response
36	NO
14	YES

20. Do you attempt of make a detailed estimate of major work items?

Number of DOTs	Response
31	NO
19	YES

21. Do you attempt to make an estimate of project overhead costs (those project related costs that cannot be attributed to specific work items – required safety staffing, quality control staffing, temporary facilities, etc.)

Number of DOTs	Response
39	NO
11	YES

22. How are mobilization and traffic control costs estimated?

Number of DOTs	Response
20	Mobilization: Set % for all contracts
26	Mobilization: Historic average % based on project analysis
4	Mobilization: Graduated or sliding % scale
20	Traffic Control: Set %
30	Traffic Control: Individual line items

23. Does your DOT ever provide materials for contractors such as aggregate, concrete, or asphalt? If so, when and why?

Number of DOTs	Response
27	NO
23	YES

24. How are unique/specialty items priced? Those items for which historic costs are not available. Is there a review of the additional costs required to meet social goals?

MBE/WBE/DBE Yes ____ No ____.

Project agreements. Yes ____ No ____.

Noise control Yes ____ No ____.

Limited work times. Yes ____ No ____.

Other ____________ Yes ____ No ____.

Number of DOTs					Response
a	b	c	d	e	
42	35	37	20	45	NO
8	15	13	30	5	YES

25. Is the cost of demolition identified separately? Yes ____ No ____.

Number of DOTs	Response
4	NO
46	YES

26. Are the costs of detours identified separately or included with traffic control?

Number of DOTs	Response
21	Separate detour pay item
11	Included with traffic control
3	Depends on size of detour
13	Included in other estimate items
2	No response

27. Are state estimates ever released to the general public? If so, when and at what level of detail?

Number of DOTs	Response
20	Project ranging only
10	DOT estimate total announced at letting
19	Entire DOT estimate with bid tabs
1	Entire DOT estimate available at advertisement

28. Are all projects awarded to a single general contractor or will specialty portions, such as bridges, be awarded separately? And at what economic level?

Number of DOTs	Response
48	Single GC
1	Separate contracts for individual work types
1	No Response

29. Are alternative project delivery methods allowed for use by state law? If so, how are these projects estimated differently than traditional design-bid-build projects? Additionally, what methods are you using and for what size and type of projects?

Number of DOTs	Response
18	NO
30	YES
2	No Response

30. Does your DOT use A + B bidding? If yes, how are the two values used to determine a low bidder?

Number of DOTs	Response
12	NO
37	YES
1	No Response

31. Is life cycle cost considered at any stage of project development.

Number of DOTs	Response
9	NO
37	YES
4	No Response/Unknown

32. How much time typically lapses between the department's estimate calculation and the bid opening?

Number of DOTs	Response
5	Within one week
11	One week to one month
24	One to two months
5	Two to three months
3	Three to five months
2	More than six months

33. What steps are taken when estimates are not close to bid prices? At what percent difference are these steps taken?

Percent difference between DOT estimate and Low Bid	DOTs taking other action if percentage exceeded
No lower limit reported	26
Up to -30	1
Up to -25	2
Up to -20	2
Up to -15	2
Up to -10	5
Up to -5	2
All Projects Reviewed	8
Percentages Unknown/Unreported	2
Up to +5	3
Up to +10	31
Up to +15	2
Up to +20	2
Up to +25	2

34. Is there a contingency amount incorporated into each project estimate? If so how is this amount determined?

Number of DOTs	Response
27	NO
23	YES

35. For a conceptual estimate, what percentage (%) is used for engineering and contingency?

Number of DOTs	Conceptual Contingency
20	Set Percentage
15	Graduated Scale
15	Engineering Judgment

36. Are incentives used for early project completion, roadway smoothness or other items? If so, where does this money come from and is it set aside and planned for during estimating?

Number of DOTs	Response
26	Programmed in the construction estimate
9	Come from other projects that are below budget
10	Paid out of project contingency fund
5	No incentive program in place

37. What is the time duration that contractors have for preparing their project estimates? Does this change based of the size ($) of the project?

Number of DOTs	Response
30	3 to 4 weeks may extend if needed
5	3 to 4 weeks no extensions
15	4 weeks to three months

38. How does your DOT prevent contractor bid collusion?

Number of DOTs	Response
7	No active program
11	Contractors must sign non-collusion form with bid
34	Run bid histories and perform bid analysis
7	Separate entity responsible for this

39. What system changes are you considering and why?

Number of DOTs	Response
32	No planned changes
8	Implement TRNS*PORT to a greater degree
10	Other minor changes